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a processing unit coupled to said transducers for receiving the data from said transducers and processing the data to obtain an output indicative of the current occupancy state of the seat, a trained combination neural network created from a plurality of data sets being resident in said processing unit, each of said data sets representing a different occupancy state of the seat and being formed from data from said transducers while the seat is in that occupancy state,

said combination neural network providing the output indicative of the current occupancy state of the seat upon inputting a data set representing the current occupancy state of the seat and being formed from data from at least some of said transducers.

REMARKS

Entry of this amendment and reconsideration of the present application, as amended, are respectfully requested.

Claims 1-78 are pending in this application. Claims 1, 28, 44, 67 and 69 have been amended.

Information Disclosure Statement

The Examiner crossed out prior art cited in the Information Disclosure Statement filed on February 9, 2001, presumably because a legible copy was not provided.

The Examiner's attention is directed to MPEP §609, section A(2), Legible Copies. One exception to the general rule that a copy of each reference must be submitted is if a copy of the references were previously cited by or submitted to the Patent Office in a prior application relied upon for an earlier filing date under 35 U.S.C. §120 and which is properly identified in the Information Disclosure Statement. In this case, a parent application, U.S. patent application Ser. No. 09/474,147 is identified in the Information Disclosure Statement and this application is being relied upon for an earlier filing date under 35 U.S.C. §120. Thus, the failure to submit a copy of each reference does not amount to a failure to comply with the provisions of 37 C.F.R. §§1.97,1.98 and MPEP §609.

It is thus respectfully submitted that the Information Disclosure Statement filed May 10, 2001 was in total compliance with the provisions of 37 C.F.R. §1.97,1.98 and MPEP §609 in which case, the Examiner's should consider the crossed-out references.

However, in the event that copies of the references are unavailable in the parent application, submitted herewith is a copy of each reference crossed-out by the Examiner. It is asserted that no fee is due for the submission of copies of these references in view of the foregoing and no authorization to charge the assignee's Deposit Account is given.

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Specification

The specification has been amended to remove the tables and charts from pages 52-62 and 64-70 and to provide these tables and charts as new Figs. 18-40. As such, Appendix 1 is now set forth in the drawings so Appendices 2 and 3 have been renumbered.

The specification has been amended in light of the changes, e.g., to describe new Figs. 18-40 and refer to these drawings at appropriate locations.

No new matter is introduced by the submission of proposed new Figs. 18-40 or the attendant changes to the specification.

In view of the changes to the drawings and specification, it is respectfully submitted that the Examiner's objection to the disclosure has been overcome and should be removed.

Claim Rejections

Claims 1-78 were rejected under 35 U.S.C. §102(b) as being anticipated by Corrado et al. (U.S. Pat. No. 5,482,314).

The Examiner's rejection is respectfully traversed in view of amended independent claims 1, 28, 44, 67 and 69.

Independent claims 1, 28, 44, 67 and 69 have been amended to clarify that the combination neural network is a "trained" combination neural network. The trained combination neural network is created from a plurality of data sets and produces an output indicative of the current occupancy state of the seat upon inputting a data set representing the current occupancy state of the seat (claim 1).

Corrado et al. does not teach or suggest use of a trained combination neural network for occupancy state determination. Rather, Corrado et al. is based on the use of a process referred to as "sensor fusion" as discussed in the specification at page 5. In a preferred embodiment of the sensor fusion process used in Corrado et al., signals from infrared and ultrasonic sensors are input into a microprocessor by means of a sensor fusion algorithm to produce an output signal (col. 7, lines 15-18). During operation, the fusion processing compares the signals to a matrix of known condition confidence values to produce a set of confidence weighted values (col. 7, lines 28-32).

In light of the foregoing, it is respectfully submitted that the sensor fusion process is not "trained" in that it is not taught to recognize various patterns constituted within signals by subjecting the process to a variety of examples. A definition of a trained or trainable pattern recognition system, of which a combination neural network is an example, is provided in the specification at page 6, lines 21-33.

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To buttress the difference between a trained combination neural network as now set forth in claims 1, 28, 44, 67 and 69 and the sensor fusion process of Corrado et al., a Declaration by Inventor David S. Breed Under 37 C.F.R. §1.132 is attached. As set forth therein, a sensor fusion algorithm is fundamentally different than a trained combination neural network and one skilled in the art of occupancy determination systems would not have been motivated to use a trained combination neural network instead of the sensor fusion process of Corrado et al.

The Examiner referred to Col. 6, line 21-25 of Corrado et al. to show or reference a neural network. However, this portion of the specification does not mention anything about the use of any type of trained pattern recognition algorithm such as a trained combination neural network.

Thus, Corrado et al. does not teach or suggest the embodiments of the invention now set forth in claims 1, 28, 44, 67 and 69, as well as the embodiments of claims 2-27, 29-43, 45-66, 68 and 70-78 which depend from claim 1, 28, 44, 67 or 69.

In view of the changes made to independent claims 1, 28, 44, 67 and 69 and the arguments presented above, it is respectfully submitted that the Examiner's rejection of claims 1-78 under 35 U.S.C. §102(b) as being anticipated by Corrado et al. has been overcome and should be removed.

Double Patenting

Claims 1-78 were provisionally rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-56 of co-pending U.S. patent application Ser. No. 09/382,406 (the '406 application).

Without addressing the validity of this rejection, submitted herewith is a Terminal Disclaimer disclaiming the terminal part of any patent granted on this application which would extend beyond the term of any patent granted on the '406 application. As noted in the Terminal Disclaimer, the appropriate fee for submission of a Terminal Disclaimer is to be charged to the current assignee's Deposit Account.

In view of the submission of the Terminal Disclaimer, it is respectfully submitted that the obviousness-type double patenting rejection has been overcome and should be removed.

In view of the foregoing, it is respectfully submitted that the present application in now in condition for allowance.

If the Examiner should determine that minor changes to the claims to obviate informalities are necessary to place the application in condition for allowance, the Examiner is respectfully requested to contact the undersigned to discuss the same.

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An early and favorable action on the merits is earnestly solicited.

FOR THE APPLICANTS
Respectfully submitted,

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Enc.
Version with Markings to Show Changes Made
Proposed new Figs. 18-40
Letter to Draftsman
Terminal Disclaimer
Declaration by Inventor David S. Breed
Fee Transmittal

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

U.S. PATENT APPLICATION SER. NO. 09/853,118
ACCOMPANYING AMENDMENT OF FEBRUARY 27, 2002

In The Specification:

Paragraph beginning at page 18, line 1 has been amended as follows:

FIG. 13 is a schematic illustration of a method in which the occupancy state of a seat of a vehicle is determined using a combination neural network in accordance with the invention. [FIG. 14 is a schematic illustration of a method in which the identification and position of the occupant is determined using a combination neural network in accordance with the invention.]

FIG. 14 is a schematic illustration of a method in which the identification and position of the occupant is determined using a combination neural network in accordance with the invention.

Paragraph beginning at page 18, line 11 has been amended as follows:

FIG. 17 is a schematic illustration of a method in which the occupancy state of a seat of a vehicle is determined using a combination neural network in accordance with the invention, in particular, an ensemble arrangement of neural networks.

FIG. 18 is a database of data sets for use in training of a neural network in accordance with the invention.

FIG. 19 is a categorization chart for use in a training set collection matrix in accordance with the invention.

FIGS. 20, 21 and 22 are charts of infant seats, child seats and booster seats showing attributes of the seats and a designation of their use in the training database, validation database or independent database in an exemplifying embodiment of the invention.

FIG. 23 is a chart showing different vehicle configurations for use in training of combination neural network in accordance with the invention.

FIGS. 24A-24F show a training set collection matrix for training a neural network in accordance with the invention.

FIG. 25 shows an independent test set collection matrix for testing a neural network in accordance with the invention.

FIG. 26 is a table of characteristics of the data sets used in the invention.

FIG. 27 is a table of the distribution of the main training subjects of the training data set.

FIG. 28 is a table of the distribution of the types of child seats in the training data set.

FIG. 29 is a table of the distribution of environmental conditions in the training data set.

FIG. 30 is a table of the distribution of the validation data set.

FIG. 31 is a table of the distribution of human subjects in the validation data set.

FIG. 32 is a table of the distribution of child seats in the validation data set.

FIG. 33 is a table of the distribution of environmental conditions in the validation data set.

FIG. 34 is a table of the inputs from ultrasonic transducers.

FIG. 35 is a table of the baseline network performance.

FIG. 36 is a table of the performance per occupancy subset.

FIG. 37 is a tale of the performance per environmental conditions subset.

FIG. 38 is a chart of four typical raw signals which are combined to constitute a vector.

FIG. 39 is a table of the results of the normalization study.

FIG. 40 is a table of the results of the low threshold filter study.

Paragraph beginning at page 20, line 6 has been amended as follows:

In addition to a variety of seating states for objects in the passenger compartment, the trial database will also include environmental effects such as thermal gradients caused by heat lamps and the operation of the air conditioner and heater. A sample of such a matrix is presented in [Appendix 1] FIGS. 24A-24F, with some of the variables and objects used in the matrix being designated or described in FIGS. 18-23. After the neural network has been trained on the trial database, the trial database will be

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scanned for vectors that yield erroneous results (which would likely be considered bad data). A study of those vectors along with vectors from associated in time cases are compared with the photographs to determine whether there is erroneous data present. If so, an attempt is made to determine the cause of the erroneous data. If the cause can be found, for example if a voltage spike on the power line corrupted the data, then the vector will be removed from the database and an attempt is made to correct the data collection process so as to remove such disturbances.

Paragraph beginning at page 20, line 24 has been amended as follows:

The next set of data to be collected is the training database. This will be the largest database initially collected and will cover such setups as listed, for example, in [Appendix 1] <u>FIGS. 24A-24F</u>. The training database, which may contain 500,000 or more vectors, will be used to begin training of the neural network. While this is taking place additional data will be collected according to [Appendix 1] <u>FIGS. 20-22 and 25</u> of the independent and validation databases. The training database has been selected so that it uniformly covers all seated states that are known to be likely to occur in the vehicle. The independent database may be similar in makeup to the training database or it may evolve to more closely conform to the occupancy state distribution of the validation database. During the neural network training, the independent database is used to check the accuracy of the neural network and to reject a candidate neural network design if its accuracy, measured against the independent database, is less than that of a previous network architecture.

Paragraph beginning on page 37, line 28 has been amended as follows:

The process for adapting an ultrasonic system to a vehicle will now be described. A more detailed list of steps is provided in Appendix [3] <u>2</u>. Although the pure ultrasonic system is described here, a similar or analogous set of steps applies when other technologies such as weight and optical or other electromagnetic wave systems such as capacitance and field monitoring systems are used. This description is thus provided to be exemplary and not limiting:

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Phrase at page 63, line 1, has been amended as follows:

Appendix [2] 1.

Paragraph beginning at page 64, line 1 has been amended as follows:

[Table 1] FIG. 26 shows the main characteristics of these three data sets, as collected for the vehicle. Three numbers characterize the sets. The number of configurations characterizes how many different subjects and objects were used. The number of setups is the product of the number of configurations and the number of vehicle interior variations (seat position and recline, roof and window state, etc.) performed for each configuration. The total number of vectors is then made up of the product of the number of setups and the number of patterns collected while the subject or object moves within the passenger volume.

Paragraph beginning at page 64, line 12, has been amended as follows:

The training data set can be split up in various ways into subsets that show the distribution of the data. [Table 2] FIG. 27 shows the distribution of the training set amongst three classes of passenger seat occupancy: Empty Seat, Human Occupant, and Child Seat. All human occupants were adults of various sizes. No children were part of the training data set other then those seated in Forward Facing Child Seats. [Table 3] FIG. 28 shows a further breakup of the Child Seats into Forward Facing Child Seats, Rearward Facing Child Seats, Rearward Facing Infant Seats, and out-of-position Forward Facing Child Seats. [Table 4] FIG. 29 shows a different type of distribution; one based on the environmental conditions inside the vehicle.

Paragraph beginning at page 65, line 12, has been amended as follows:

The distribution of the validation data set into its main subsets is shown in [Table 5] FIG. 30. This distribution is close to that of the training data set. However, the human occupants comprised both

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children (12% of total) as well as adults (27% of total). [Table 6] FIG. 31 shows the distribution of human subjects. Contrary to the training and independent test data sets, data was collected on children ages 3 and 6 that were *not* seated in a child restraint of any kind. [Table 7] FIG. 32 shows the distribution of the child seats used. On the other hand, no data was collected on Forward Facing Child Seats that were out-of-position. The child and infant seats used in this data set are different from those used in the training and independent test data sets. The validation data was collected with varying environmental conditions as shown in [Table 8] FIG. 33.

Paragraph beginning on page 67, line 1, has been amended as follows:

The baseline network consisted of a four layer back-propagation network with 117 input layer nodes, 20 and 7 nodes respectively in the two hidden layers, and 1 output layer node. The input layer is made up of inputs from four ultrasonic transducers. These were located in the vehicle on the rear quarter panel (A), the A-pillar (B), and the over-head console (C, H). [Table 9] FIG. 34 shows the number of points, taken from each of these channels that make up one vector.

Paragraph beginning on page 67, line 12, has been amended as follows:

The network was trained using the above-described training and independent test data sets. An optimum (against the independent test set) was found after 3,675,000 training cycles. Each training cycle uses 30 vectors (known as the epoch), randomly chosen from the 650,000 available training set vectors. [Table 10] FIG. 35 shows the performance of the baseline network.

Paragraph beginning on page 67, line 17, has been amended as follows:

The network performance has been further analyzed by investigating the success rates against subsets of the independent test set. The success rate against the airbag enable conditions at 94.6% is virtually equal to that against the airbag disable conditions at 94.4%. [Table 11] FIG. 36 shows the success rates for the various occupancy subsets. [Table 12] FIG. 37 shows the success rates for the

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environmental conditions subsets. Although the distribution of this data was not entirely balanced throughout the matrix, it can be concluded that the system performance is not significantly degraded by heat sources.

Paragraph beginning at page 68, line 11 has been amended as follows:

The real world data consists of 12 bit, digitized signals with values between 0 and 4095. [Chart 1] FIG. 38 shows a typical raw signal. A raw vector consists of combined sections of four signals.

Paragraph beginning on page 69, line 9, has been amended as follows:

The results of the normalization study are summarized in [Table 13] FIG. 39.

Paragraph beginning on page 69, line 17, has been amended as follows:

Normalization using a fixed range retains the information contained in the relative strength of one vector compared to the next. From this it could be expected that the performance of the network trained with fixed range normalization would increase over that of the baseline method. However, without normalization, the input range is, as a rule, not from zero to the maximum value (see [Figure 1] FIG. 39). The absolute value of the data at the input layer affects the network weight adjustment (see equations (1) and (2)). During network training, vectors with a smaller input range will affect the weights calculated for each processing element (neuron) differently than vectors that do span the full range.

Paragraph beginning on page 70, line 29, has been amended as follows:

The results of the low threshold filter study are summarized in [Table 14] FIG. 40.

Phrase at page 73, line 1, has been amended as follows:

Appendix [3] 2.

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IN THE CLAIMS:

Please amend claims 1, 28, 44, 67 and 69 as follows.

1. (Amended) A vehicle including a system for determining the occupancy state of a seat in the vehicle occupied by an occupying item, the system comprising:

a plurality of transducers arranged in the vehicle, each of said transducers providing data relating to the occupancy state of the seat; and

processor means coupled to said transducers for receiving the data from said transducers and processing the data to obtain an output indicative of the current occupancy state of the seat, said processor means comprising a <u>trained</u> combination neural network created from a plurality of data sets, each of said data sets representing a different occupancy state of the seat and being formed from data from said transducers while the seat is in that occupancy state,

said combination neural network producing the output indicative of the current occupancy state of the seat upon inputting a data set representing the current occupancy state of the seat and being formed from data from at least some of said transducers.

28. (Amended) A method of developing a system for determining the occupancy state of a seat in the vehicle occupied by at least one occupying item, comprising the steps of:

mounting transducers in the vehicle;

forming at least one database comprising multiple data sets, each of the data sets representing a different occupancy state of the seat and being formed by receiving data from the transducers while the seat is in that occupancy state, and processing the data received from the transducers;

creating a <u>trained</u> combination neural network from the at least one database capable of producing an output indicative of the occupancy state of the seat upon inputting a data set representing an occupancy state of the seat; and

inputting a data set representing the current occupancy state of the seat into the combination neural network to obtain the output indicative of the current occupancy state of the seat.

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44. (Amended) A method of developing a database for use in developing a system for determining the occupancy state of a vehicle seat by an occupying item, comprising the steps of:

mounting transducers in the vehicle;

providing the seat with an initial occupancy state;

receiving data from the transducers;

processing the data from the transducers to form a data set representative of the initial occupancy state of the vehicle seat;

changing the occupancy state of the seat and repeating the data collection process to form another data set;

collecting at least 1000 data sets into a first database, each data set representing a different occupancy state of the seat;

creating a <u>trained</u> combination neural network from the first database which correctly identifies the occupancy state of the seat for most of the data sets in the first database;

testing the combination neural network using a second database of data sets which were not used in the creation of the combination neural network;

identifying the occupancy states in the second database which were not correctly identified by the combination neural network;

collecting new data comprising similar occupancy states to the incorrectly identified states;

combining this new data with the first database;

creating a new combination neural network based on the combined database; and

repeating this process until the desired accuracy of the combination neural network is achieved.

67. (Amended) A method of developing a system for determining the occupancy state of a vehicle seat in a passenger compartment of a vehicle, comprising the steps of:

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mounting a set of transducers on the vehicle;

receiving data from the transducers;

processing the data from transducers to form a data set representative of the occupancy state of the vehicle;

forming a database comprising multiple data sets;

creating a trained combination neural network from the database capable of producing an output indicative of the occupancy state of the vehicle seat upon inputting a new data set;

developing a measure of system accuracy;

removing at least one of the transducers from the transducer set;

creating a new database containing data only from the reduced number of transducers;

creating a new combination neural network based on the new database;

testing the new combination neural network to determine the new system accuracy; and

continuing the process of removing transducers, combination neural network creation and testing until the minimum number of sensors is determined which produces a combination neural network having desired accuracy.

69. (Amended) A vehicle including a system for determining the occupancy state of a seat in the vehicle occupied by an occupying item, the system comprising:

a plurality of transducers arranged in the vehicle, each of said transducers providing data relating to the occupancy state of the seat; and

a processing unit coupled to said transducers for receiving the data from said transducers and processing the data to obtain an output indicative of the current occupancy state of the seat, a trained combination neural network created from a plurality of data sets being resident in said processing unit, each of said data sets representing a different occupancy state of the seat and being formed from data from said transducers while the seat is in that occupancy state,

said combination neural network providing the output indicative of the current occupancy state of the seat upon inputting a data set representing the current occupancy state of the seat and being formed from data from at least some of said transducers.